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(54) OFFSHORE STRUCTURE

(71) We, THE BRITISH PETROLEUM COMPANY LIMITED, of Britannic House, Moor Lane, London EC2Y 9BU, a British Company, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed to be particularly described in and by the following statement:–

This invention relates to a structure suitable for installation at an offshore location by means of members, e.g. mooring lines maintained under tension.

Structures for oil production which are moored below their free floating position by means of mooring members maintained under tension have been previously described e.g. in USP 3,648,638 and UK patent 1,337,601 and have been called tethered buoyant platforms or tension leg platforms.

A structure has now been invented which is suitable for mooring at an offshore location below its free floating position by means of members maintained under tension and which can be employed in a number of different uses, e.g. as an oil riser, as a support for a flare or as a mooring point for a tanker.

Thus according to the present invention a structure suitable for mooring at an offshore location by means of mooring members maintained under tension comprises:–

(a) a rigid tubular member suitable for the flow of fluids therethrough.

(b) a buoyancy chamber attached to the rigid tubular member;

(c) and a ballast chamber attached to the rigid tubular member and axially spaced apart from the buoyancy chamber,

the structure being suitable for floating in a horizontal attitude and uprightable by the admission of water to the ballast chamber, the buoyancy of the buoyancy chamber in relation to the ballasting of the ballast chamber being such that, when the buoyancy chamber is wholly submerged, the buoyancy of the structure exceeds its weight and the structure can be moored in an upright attitude with the buoyance chamber above the ballast chamber by means of mooring members maintained under tension and wherein the rigid tubular member has attached to the lower end thereof a connector for connection to a second member, said second member being fixed relative to the sea bed, the connector being suitable for the flow of fluids therethrough and being in the form of a helix to give the connector sufficient flexibility to accommodate movement of the rigid tubular member in relation to the second member fixed relative to the sea bed.

The helical connector can include a ball joint and/or telescopic joint to assist in accommodating the movement of the end of the rigid tubular member relative to the second member fixed relative to the sea bed.

Preferably the structure is symmetrical with respect to its longitudinal axis, which when the structure is installed is a vertical axis.

Conveniently the buoyancy chamber is spherical or of an elongated shape, e.g. cylindrical and preferably is symmetrically disposed with respect to the axis of the tubular member.

Preferably the buoyancy chamber is divided into a number of compartments, the compartments being controllably floodable, for example by means of internal transverse and longitudinal partitions hereafter referred to as decks and bulk heads.

Preferably the rigid tubular member is divided into a number of compartments by decks.

The ballasting chamber preferably contains some fixed heavier than water material, e.g. concrete or haematite. Preferably the chamber is divided into a number of compartments, e.g. by means of decks and

bulkheads.

According to one aspect of the invention a structure as hereinbefore described is moored to the sea bed below its free floating position by means of mooring members maintained under an applied tension and wherein the mooring members are attached to points on the buoyancy chamber and to points on the ballast chamber and the corresponding points on the buoyancy chamber an ballast chamber are in alignment when viewed along the longitudinal axis of the structure.

Preferably the attachment points on the ballast chamber are near the lower extremity of the ballast chamber. When the mooring members are cables they are conveniently of a material having a neutral buoyancy such as steel having buoyancy compensation or a polyester fibre encased in polyethylene, e.g. that sold by ICI under the trade name of 'Parafil'.

The attachment points on the buoyancy chamber are preferably three or more in number, and can be coplanar and equally spaced around the buoyancy chamber and arranged to be substantially coplanar with or below the plane containing the centre of buoyancy of the buoyancy chamber.

Conveniently the plane containing the centre of buoyancy of the buoyancy chamber is spaced apart from the nearest part of the ballast chamber by a distance at least equal to the greatest dimension of the buoyancy chamber e.g. in the case of a cylindrical buoyancy chamber by a distance equal to its longitudinal axis and not more than six such dimensions. Thus the length of the rigid elongate tubular member between the buoyancy chamber and the ballast chamber can be from about ½ to 5½ times the greatest dimension of the buoyancy chamber.

A number of anchor points can be arranged on the sea bed disposed at the corners of a regular or non regular polygon. Preferably the polygon has from three to six sides. Alternatively the anchor points can be offset e.g. when the structure is to be installed when there is a prevailing current.

Preferably each anchor point on the sea bed is connected directly by means of a mooring member to one of the attachment points on the buoyancy means, preferably an attachment point at or near the middle of the buoyancy means, and also to an attachment point on the ballast means.

According to another aspect of the invention method of installing a structure as hereinbefore defined at an underwater location comprises floating the structure to the location in a substantially horizontal attitude, admitting ballast to the ballast chamber to upright the structure and attaching the mooring members to the structure and connecting the mooring means to the water bottom and applying tension thereto to draw the structure into the water against its buoyancy.

The invention is illustrated by the drawings accompanying the provisional specification which in Figure 1 shows a side elevation of a structure according to the invention installed at an offshore location, and which in Figure 2 shows a plan view of the structure also installed at an offshore location. In Figure 1 the structure, indicated generally by numeral 20, is shown in an upright posture and comprises a rigid elongate tubular member in the form of a steel pipe 1 about 100m in length and diameter about 3m, a buoyancy chamber 2 attached to the steel pipe 1, a floodable ballast chamber 3 partly filled with concrete and mooring members in the form of cables 4 and 24 having a neutral buoyancy. The structure is symmetrical with respect to its vertical axis.

The buoyancy chamber 2 is divided into water-tight compartments by six radial bulkheads and two decks (not shown). The steel pipe 1 is also divided into water-tight compartments by three decks (not shown), which compartments are air filled.

The ballast chamber 3 is divided into controllably floodable compartments by decks and bulkheads (not shown) in a manner similar to the buoyancy chamber.

Dotted line 5 indicates the water level when the structure is floating unmoored. Continuous line 6 indicates the water level when the structure is moored with cables 24 under tension and buoyancy chamber 2 wholly submerged.

The buoyancy chamber 2 is of cylindrical shape and its axis is colinear with the axis of the steel pipe. The ballast chamber 3 is also of cylindrical shape and its axis is also colinear with the axis of the steep pipe 1. The diameter of the ballast chamber 3 is substantially the same as that of the buoyancy chamber 2.

The buoyancy chamber 2 has six attachment points 7, substantially coplanar with the centre of buoyancy of the chamber for cables 4. Located on the exterior of the buoyancy chamber 2 at a level below attachment points 7 is a cable stopper ring 17 to take the forces generated by the cable tension.

Ballast chamber 3 also has six cable stoppers on ring 10 arranged in a horizontal plane and equally spaced around the chamber. At the base of the ballast chamber 3 are remotely operable stoppers 18.

Cables 4 link anchor points 12 on the sea bed with the attachment points on the buoyancy chamber and cables 24 link anchor points 12 with the lower attachment points on buoyancy chamber 2 via cable

stopper ring 10 on ballast chamber 3. Cables 4 and 24 and their attachment points 7 and 10 on the buoyancy chamber 2 and ballast chamber 3 respectively and anchorage 12 lie in a vertical plane. One cable 4 runs directly from anchor point 12 to one of the attachment points 7, another cable 24 (which can form a continuous loop with cable 4) run from anchor point 12 to attachment point 10 and thence into hawse pipe (not shown) through the buoyancy chamber giving access to cable tensioning gear (not shown). A pipe 26 projects from the water surface and has a lattice tower 14 to provide support for a flare 15. Supported on the lattice tower above the water level 6 is cable tensioning gear 16.

The lower extremity of the steel pipe 1 extends below the base of the ballast chamber 3 and is connected to a flexible riser coupler 21 in the form of a helical tube which may be also flexible tube or have spherical and telescopic joints, the lower end of which is connected to a riser base 22 on the sea bed. A buoy 27 supports control cables 28 connected to the riser base 22.

Gas from sea bed line 25 flows via connector 23 to riser coupler 21 and then upwardly through th structure to the flare 15.

Figure 2 shows the sea bed anchorages 12 disposed at the corners of an equilateral triangle and the cables 4 and 24 running from the attachment points on the buoyancy chamber and ballast chamber respectively. Dotted lines show the cables in the case whereby there are six anchorages 12 disposed at the corners of a regular hexagon.

WHAT WE CLAIM IS:–

1. A structure suitable for mooring at an offshore location by means of mooring members maintained under tension comprising:–

(a) a rigid tubular member suitable for the flow of fluids therethrough;

(b) a buoyancy chamber attached to the rigid tubular member;

(c) and a ballast chamber attached to the rigid tubular member and axially spaced apart from the buoyancy chamber, the structure being suitable for floating in a horizontal attitude and uprightable by the admission of water to the ballast chamber the buoyancy of the buoyancy chamber in relation to the ballasting of the ballast chamber being such that, when the buoyancy chamber is wholly submerged, the buoyancy of the structure exceeds its weight and the structure can be moored in an upright attitude with the buoyancy chamber above the ballast chamber by means of mooring members maintained under tension and wherein the rigid tubular member has attached to the lower end thereof a connector for connection to a second member, said second member being fixed relative to the sea bed, the connector being suitable for the flow of fluids therethrough and being in the form of a helix to give the connector sufficient flexibility to accommodate movement of the rigid tubular member in relation to the second member fixed relative to the sea bed.

2. A structure as claimed in claim 1 wherein the helical connector includes a ball joint and/or telescopic joint to assist in accommodating the movement of the end of the rigid tubular member relative to the second member fixed relative to the sea bed.

3. A structure as claimed in claim 1 wherein the ballast chamber is compartmented, the compartments being controllably floodable.

4. A structure as claimed in any one of claims 1 to 3, wherein the structure is moored to the sea bed below its free floating position by means of mooring members maintained under an applied tension and wherein the mooring members are attached to points on the buoyancy chamber and to points on the ballast chamber and are in alignment when viewed along the longitudinal axis of the structure.

5. A structure as claimed in claim 4 wherein the points on the buoyancy chamber are three or more in number and disposed to be substantially coplanar with, or below, the plane containing the centre of buoyancy of the buoyancy chamber.

6. A structure as claimed in claim 4 or 5 wherein the points on the sea bed to which the mooring members are attached lie at the corners of a regular polygon.

7. A structure as claimed in claim 6 wherein each of the points on the sea bed is connected by the mooring members to the ballast chamber and to the buoyancy chamber.

8. A method of installing a structure as claimed in claim 1 at an underwater location which method comprises floating the structure to the location in a substantially horizontal attitude; admitting water to the ballast chamber to upright the structure, attaching the structure to the sea bed by mooring members and applying tension thereto to draw the structure into the water against its buoyancy.

9. A structure substantially as hereinbefore described with reference to the drawings accompanying the provisional specification.

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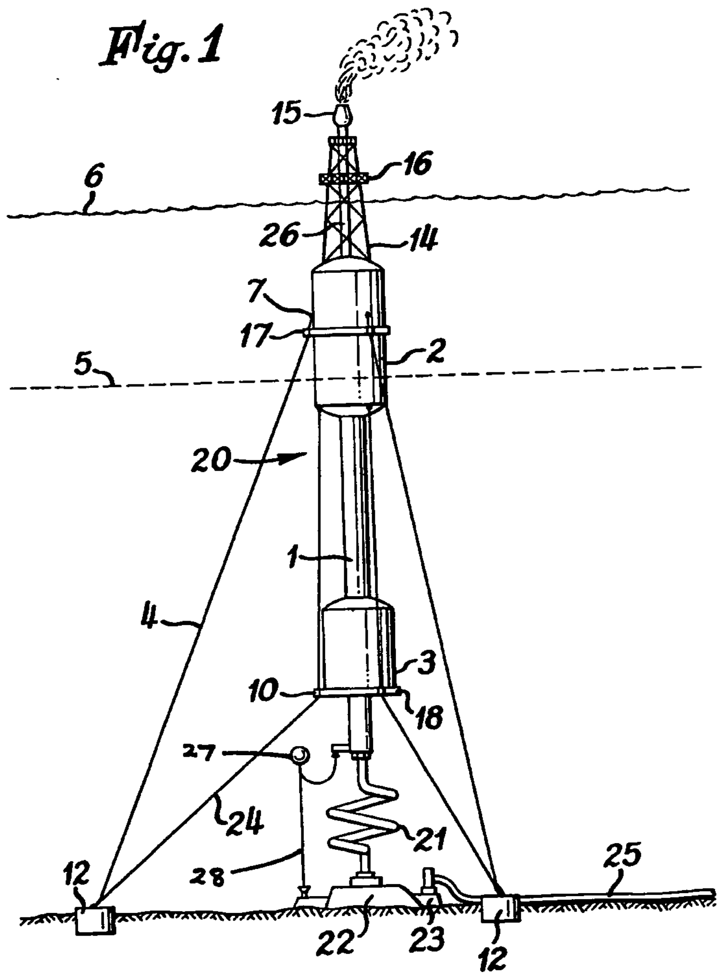
2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 1

Fig. 1



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Sheet 2

Fig. 2